

REMARKS

The application has been amended as needed so as to place it in condition for disposal at the time of the next Official Action.

Claims 1-8 were rejected under 35 USC §102(b) as being anticipated by LI et al. 5,149,512. The Official Action states that the patented reference discloses a catalytic reduction process for the reduction of nitrogen oxides using methane in the presence of oxygen. The methane is stated to serve as a reducing agent, and the catalyst is allegedly a promoted iron-containing zeolite. The precious metal may be rhodium, and the term NO<sub>x</sub> is stated to include nitrous oxide in column 3, lines 56-58. The methane to NO<sub>x</sub> ratio ranges from 0.2 to 10, and the process is carried out at a temperature of about 250°C and pressures between 1 and 300 atmospheres. It is concluded that since LI et al. disclose the same process, it would have been inherent and anticipated to achieve the emission of carbon monoxide and of the hydrocarbon being less than 100 ppmv.

Reconsideration of the above rejection is respectfully requested for the following reasons.

By the present amendment, it will be seen that newly-presented independent claim 9 includes the subject matter formerly recited in claims 1, 2 and 3, except that platinum has been excluded from the Markush group.

Thus, claim 9 calls for a method for the selective catalytic reduction of nitrous oxide ( $N_2O$ ) in the presence of a solid catalyst, with the addition of a saturated hydrocarbon as a reducing agent, wherein the catalyst used is an iron-containing zeolite promoted with at least one precious metal selected from the group consisting of ruthenium, rhodium, palladium and gold.

According to the Official Action, the abstract of the LI et al. reference discloses that the catalyst may be promoted with a precious metal, such as rhodium.

It is however pointed out that the abstract fails to disclose such information, but only discloses that the zeolites are exchanged with a cation selection from the group consisting of cobalt, nickel, iron, chromium, rhodium and manganese. Thus, the patented reference fails to directly and unambiguously disclose an iron-containing zeolite, which is promoted with a precious metal. In Tables 1a and 2 of the patented reference, several zeolites containing two metal ions are disclosed. However, none of these zeolites comprise iron.

Although LI et al. may disclose a broad range of metal containing zeolites, and even zeolites comprising two metals, the specific selection of an iron-containing zeolite **promoted** with a precious metal selected from the group consisting of ruthenium, rhodium, palladium and gold is simply neither disclosed, nor suggested. Consequently, it is respectfully submitted that

newly-presented independent claim 9, and independent claim 18, which includes similar recitation as claim 9, are neither disclosed, nor suggested by the LI et al. reference.

The Official Action refers to column 3, lines 54-58, to support the proposition that NO<sub>x</sub> is intended to encompass nitrous oxide. It is however pointed out that the definition provided in the patent is simply incorrect, as the mechanism by which nitrous oxide is reduced differs from the mechanism by which NO, and NO<sub>2</sub> are reduced. In this particular art, nitrous oxide is simply not comprised in the group of NO<sub>x</sub>. A person having ordinary skill in the art would readily know that zeolites which are suitable for the reduction of nitrous oxide are not necessarily suitable for the reduction of NO and NO<sub>2</sub>.

This is confirmed by Applied Catalysis 64, 1990 (an abstract of which is enclosed), where it appears that the reduction of NO<sub>x</sub> with propane over a zeolite catalyst leads to the formation of nitrous oxide. Table 1 of this publication also shows that this catalyst does not reduce both NO<sub>x</sub> and nitrous oxide, but only NO<sub>x</sub>. Consequently, this zeolite catalyst is not suitable for the reduction of nitrous oxide. Additional proof may be found in Applied Catalysis B 25, 2000, 191-203 (an abstract of which is enclosed), wherein it is shown that a first catalyst is used for the reduction of NO<sub>x</sub>, whereby however large amounts of nitrous oxide are formed. A second, zeolite based

catalyst is necessary for the decomposition of nitrous oxide. This clearly shows that a zeolite based catalyst alone cannot efficiently reduce both NO<sub>x</sub>, that is NO, and nitrous oxide.

In the art, the definition of NO<sub>x</sub> is sometimes used confusingly, which appears to be the case in the LI et al. reference. In actuality, the LI et al. patent shows that the definition of NO<sub>x</sub> is only directed to NO, and not N<sub>2</sub>O. This can be derived from Example 5, where NO<sub>x</sub> mentioned in column 10, line 7 is really defined as NO in column 10, line 12. This is again repeated in column 10, lines 35, 44, and 58-61, where NO<sub>x</sub> and NO are once more coupled as being identical in this patented reference. Moreover, all other experiments show that NO<sub>x</sub> only comprises NO (see Tables 1A and 2-9). Finally, in column 15, lines 27-33, the patentees conclude that the claimed catalysts are active in converting NO to nitrogen gas. Hence, it would appear that the LI et al. reference is only enabled for NO. Consequently, none of the newly-presented claims 9-25 are believed to be disclosed, or suggested by the LI et al. reference.

The only time that LI et al. mention iron is in Table 2, where it appears that Runs 11b and 14 are less active catalysts with respect to most of the other catalysts mentioned in this table. Thus, even if a person having ordinary skill in the art would somehow think that catalysts applicable for NO

reduction, as taught by LI et al. could also be applied for nitrous oxide reduction, the LI et al. reference would teach away from using iron-containing zeolites, let alone iron-containing zeolites promoted with a precious metal selected from the group consisting of ruthenium, rhodium, palladium or gold.

In view of the present amendment and the foregoing remarks, therefore, it is believed that this application has been placed in condition for allowance. Reconsideration and allowance on the basis of new claims 9-26 are accordingly solicited.

In the event that there are any questions relating to this amendment or to the application in general, it would be appreciated if the Examiner would telephone the undersigned attorney concerning such questions so that the prosecution of this application may be expedited.

The Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

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Application No. 10/070,317  
Amdt. dated March 2, 2004  
Reply to Office Action of November 5, 2003  
Docket No. 2001-1019

Appendix:

The Appendix includes the following items:

- abstract from Applied Catalysis 64, 1990
- abstract from Applied Catalysis B 25, 2000, 191-203

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# Simultaneous, catalytic removal of nitric oxide and nitrous oxide

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Received 9 March 1993; revised 7 June 1993. Available online 2 August 2001.

## Abstract

The simultaneous, catalytic removal of nitrous oxide and nitric oxide in the presence of oxygen and methane or propane was studied over Co-ZSM-5. Methane is used for the reduction of nitric oxide while the nitrous oxide is able to compete for the metal sites to undergo simultaneous decomposition. Interestingly, while  $\text{NO}_x$  removal by methane does not readily occur without any oxygen, the presence of nitrous oxide actually enhances the conversion of nitric oxide in the absence of oxygen.

**Author Keywords:** Co-ZSM-5; decomposition; nitrous oxide; nitric oxide; reduction; zeolites



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This Document

▶ **Abstract**• [PDF \(322 K\)](#)

Actions

• [E-mail Article](#)**Dual-bed catalytic system for NO<sub>x</sub>-N<sub>2</sub>O removal: a practical application for lean-burn deNO<sub>x</sub> HC-SCR**J. Pérez-Ramírez<sup>a,✉</sup>, J. M. García-Cortés<sup>b</sup>, F. Kapteijn<sup>a</sup>, M. J. Illán-Gómez<sup>b</sup>, A. Ribera<sup>a</sup>, C. Salinas-Martínez de Lecea<sup>b</sup> and J. A. Moulijn<sup>a</sup><sup>a</sup> Industrial Catalysis, DelftChemTech, Delft University of Technology, Julianalaan 136, 2628 BL Delft, The Netherlands<sup>b</sup> Department of Inorganic Chemistry, University of Alicante, P.O. Box 99, E-03080, Alicante, Spain

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**Abstract**

A dual-bed catalytic system has been developed by which NO<sub>x</sub> and N<sub>2</sub>O are successively removed from flue gases, simulating lean-burn engine conditions. NO<sub>x</sub> is removed in the first stage by selective catalytic reduction with propene over a Pt supported on activated carbon catalyst. The second bed decomposes the N<sub>2</sub>O formed in the first bed into N<sub>2</sub> and O<sub>2</sub>.

Catalysts tested in this second stage comprise ex-Co-Rh, Al-HTlc and ex-Co, Pd-La, Al-HTlc mixed oxides derived from hydrotalcite-like compounds and ion-exchanged Fe-ZSM-5 and Pd-ZSM-5 zeolites. Variables studied for the most promising deN<sub>2</sub>O catalysts are the effect of the pretreatment, the sodium content of the ex-HTlc-catalysts, the presence of inhibitors in the feed stream, the addition of hydrocarbons to enhance the N<sub>2</sub>O reduction in the second bed, and both time-on-stream and thermal stability of the catalytic system. Ex-Co-Rh, Al-HTlc proved to be the most active and stable catalyst, followed by Fe-ZSM-5, even when propene was added as reducing agent, which enhanced the conversion over the latter catalyst only. In an optimal configuration, at a temperature of 475 and 700 K in the first and second stage, respectively, molar conversions of 90 and 100% for NO<sub>x</sub> and N<sub>2</sub>O were achieved in a stable operation during 50 h.

**Author Keywords:** NO<sub>x</sub>; N<sub>2</sub>O; Dual-bed system; Pt/activated carbon; Calcined hydrotalcite; Ex-Co-Rh; Al-HTlc; Ex-Co; Pd-La; Al-HTlc; Fe-ZSM-5; Pd-ZSM-5; Propene